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NEW ENGLAND AQUARIUM CHARLESTOWN NAVY YARD RELOCATION TRANSPORTATION ANALYSIS

prepared for

NEW ENGLAND AQUARIUM

February 15, 1989

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by

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TRANSPORTATION ANALYSIS

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I. INTRODUCTION AND SUMMARY

This report presents an analysis of the transportation impacts of a new Aquarium facility located at Drydock #2 in the Charlestown Navy Yard. Figure 1 illustrates the general location of the current New England Aquarium on Central Wharf in downtown Boston and the proposed new facility at Drydock #2 in the Charlestown Navy Yard.

The conclusion of the transportation analysis, under the assumptions summarized below, is that the proposed Aquarium at Drydock #2 in the Charlestown Navy Yard can be accommodated from a traffic and parking standpoint in the 1994 design year with a projected visitation level of 2.1 million per year and 300 employees. This conclusion, however, requires that parking be developed for visitors to the site; that a number of traffic improvements be made at key locations, depending on the site(s) ultimately chosen for parking facilities; and that pedestrian and transit access to the Charlestown Navy Yard be improved.

Assumptions

A number of alternative scenarios related to Aquarium visitation levels and the travel characteristics of Aquarium visitors were evaluated to determine the possible range of transportation impacts. These results were then used to define a working scenario for further analysis. Actions required to assure that the transportation network in and around the Navy Yard will function with the Aquarium in place were identified. The following assumptions are being used to define the working scenario for an opening year of 1994:

- o There will be 1.9 to 2.0 million annual visitors to the Aquarium in 1994 (compared to 1.3 million annual visitors to the existing facility in 1987). To be conservative, an annual visitation of 2.1 million was used in the analysis.
- o There will be 300 persons employed at the Aquarium during the peak season.
- o Forty-five percent (45%) of aquarium employees will commute to work by means other than private automobile. This assumption is the same as that used for the balance of the Navy Yard employees.
- o Twenty-five percent (25%) of visitors will arrive at the Navy Yard Aquarium by means other than private automobile, including water transportation, surface public transportation, tour bus, taxi and walking.
- o The average visitor length of stay will be two and one-half hours.
- o The average vehicle occupancy for Aquarium visitors will be 2.5 people per vehicle.
- o The percentage of total annual visitors in July and August will rise from the current level of 26.8% to 32.4%.
- o On peak days during the summer 25% of total visitors to the Navy Yard will go to both the Aquarium and the USS Constitution.

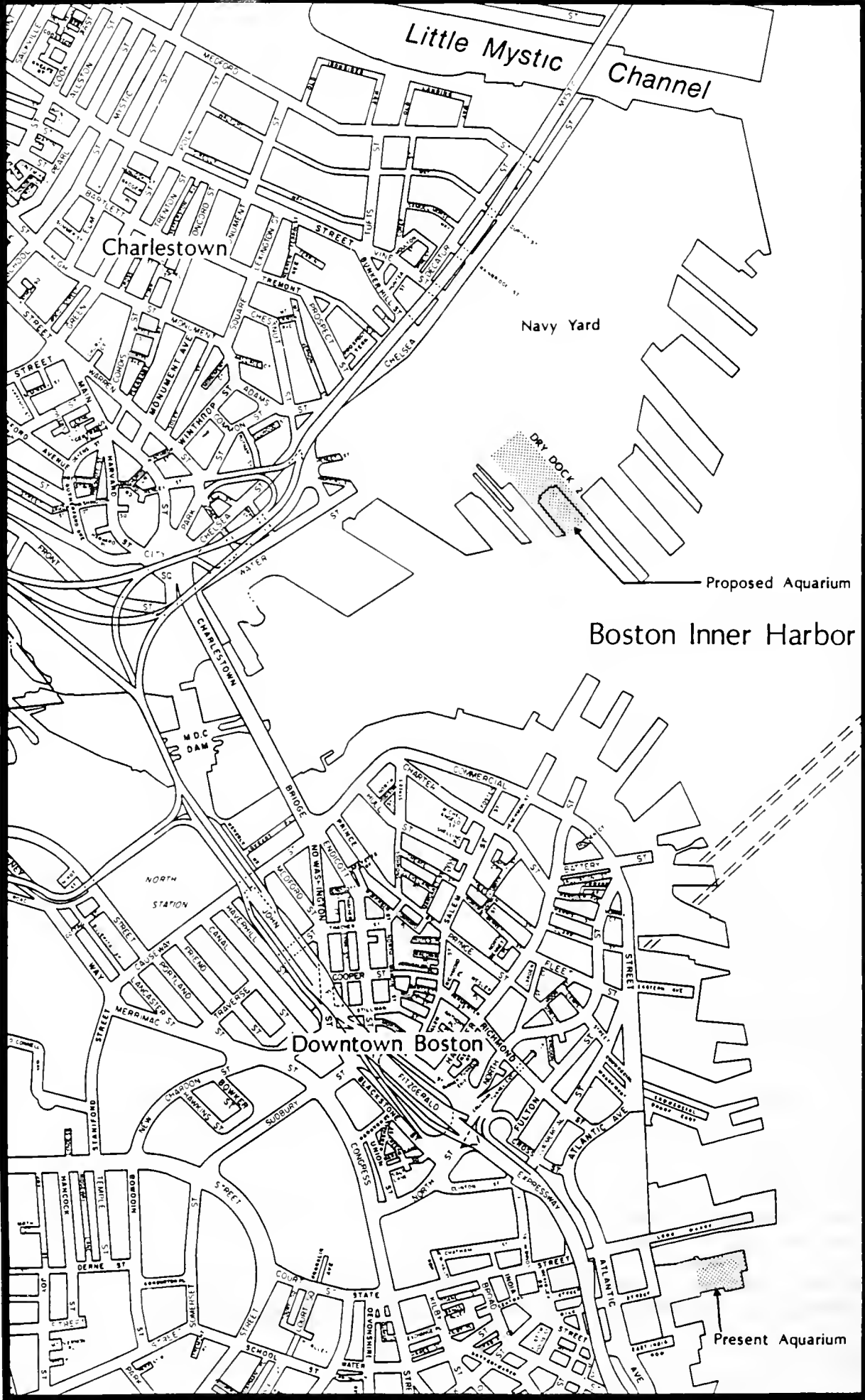


Figure 1

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Present
and
Proposed
Site Locations

In conducting the transportation analysis an additional set of assumptions were made regarding background development and traffic conditions. These include:

- o The Central Artery North Area Project (I-93/Route 1 Interchange) will be completed as planned by the 1994 design year, and the City Square Intersection will be improved as per the proposal of the Boston Transportation Department.
- o The balance of development in the Navy Yard will be completed in accordance with the plan proposed by the Boston Redevelopment Authority (BRA), dated May 10, 1988.
- o The Navy Yard will contain a total of 3,600 to 4,300 parking spaces after full development, not including any parking built expressly for the Aquarium.
- o The Gate 5 exit from the Yard to Chelsea Street will be widened to two outbound lanes.
- o Access through Gate 1 will be provided to allow buses to reach the Aquarium and avoid the difficult right turn from Chelsea Street to the Gate 4 entrance.
- o Forty-five percent (45%) of the Navy Yard employees will use public transportation to travel to and from work in the 1994 design year.
- o Other traffic generating activities in the area, such as the USS Constitution, will grow in line with the forecasts developed by the Central Transportation Planning Staff (CTPS), used in the planning work for the Central Artery North Area Project.
- o Tudor Wharf will be redeveloped as per the proposal described in the Draft Environmental Report of October, 1988.

In reviewing the results of the transportation analysis, it is important to keep in mind that a range of reasonable assumptions can be made, and that the results can vary greatly as different assumptions are used. In this analysis, reasonable upper and lower limits were tested for key assumptions, such as the percentage of visitors using public transportation to reach the Navy Yard Aquarium site. Other assumptions such as the development level of other uses in the Navy Yard and the level of transit utilization by Navy Yard employees can be influenced by policy and were not varied. However, if the BRA's development plan were to change this could alter the conclusions of the analysis.

The assumption that 45% of Navy Yard employees will use public transportation is supported by current experience. Transit use by employees of the three major tenants currently in the Yard (Massachusetts Water Resources Authority, Boston Redevelopment Authority and Massachusetts General Hospital) currently exceeds 50%. This success is a result of strong ridesharing and shuttle bus programs which will be continued and supplemented in the future with additional MBTA service to the Yard. In addition, the BRA is committed, as a matter of policy, to achieving a 45% transit mode split by Navy Yard employees.

In conducting the analysis generally conservative assumptions were used with regard to the transportation characteristics of the Aquarium. For example, the assumption that 25% of total USS Constitution and Navy Yard Aquarium visitors will overlap is conservative, since this is the current visitor overlap with the USS Constitution and the Aquarium located on separate sites. When the two attractions are located beside each other, this overlap will likely increase. As a result, any failures in the assumptions to predict future unforeseen changes should predict worse conditions than those likely to occur in the design year.

Parking Analysis Findings

Parking demand on weekdays for Aquarium visitors and employees will average approximately 700 spaces throughout most of the year. However, because of the high peak summer visitation up to 1200 spaces will be needed during some weekdays in August, and on a peak Saturday in August over 1800 spaces will be needed. This parking demand can be met in a number of ways. Since the balance of parking in the Navy Yard will be filled on weekdays, an additional supply of 700 spaces must be developed to meet average conditions and a total of 1200 spaces found to meet peak August weekday conditions. On summer Saturdays when the workforce in the balance of the Navy Yard is small, significant excess parking will be available for Aquarium visitors. The additional demand of 600 spaces compared to peak weekday conditions, therefore, can be accommodated in other facilities in the Navy Yard. It is anticipated that some of this Saturday "overflow" parking will be provided in the existing parking garage, located near Gate 5.

In addition to parking for automobiles, it will also be important to provide sufficient storage for tour and school buses in a location away from the Aquarium and the Charlestown community.

Several parking locations are being considered to meet the Aquarium's weekday needs. These sites are shown in Figures 2 and 3. In total, five generalized parking locations were assessed in this impact analysis. These sites include the Hoosac Stores area along Water Street near Gate 1, the northwest corner and tennis courts of the National Park Service (NPS) property near the intersection of Water Street and Chelsea Street, the Boston Housing Authority (BHA) site at Hayes Square, the property north of Hayes Square beneath the Tobin Bridge approaches between Decatur and Chelsea Streets, and the Tennis Courts on the NPS property across from Drydock #2. In addition, a site across the Little Mystic River was considered for the storage of school and tour buses. Because of its limited size and high development costs, Hoosac Stores was not considered further. All other sites are still under study, and represent only an initial set of locations for Aquarium parking. Other sites may be considered in the future.

In developing a strategy for meeting the Aquarium's parking needs consideration should also be given to the fact that many visitors will be unfamiliar with the Charlestown area. Thus, to avoid confusion and the possibility of traffic circulating on local Charlestown Streets, parking access should be made as simple as possible from the City Square area either as a result of location or good signage. From this perspective a large, centralized facility is preferable over multiple, smaller locations. Finally, sites providing quick and easy pedestrian access between parking and Drydock #2 are preferable to those sites requiring a shuttle bus connection.

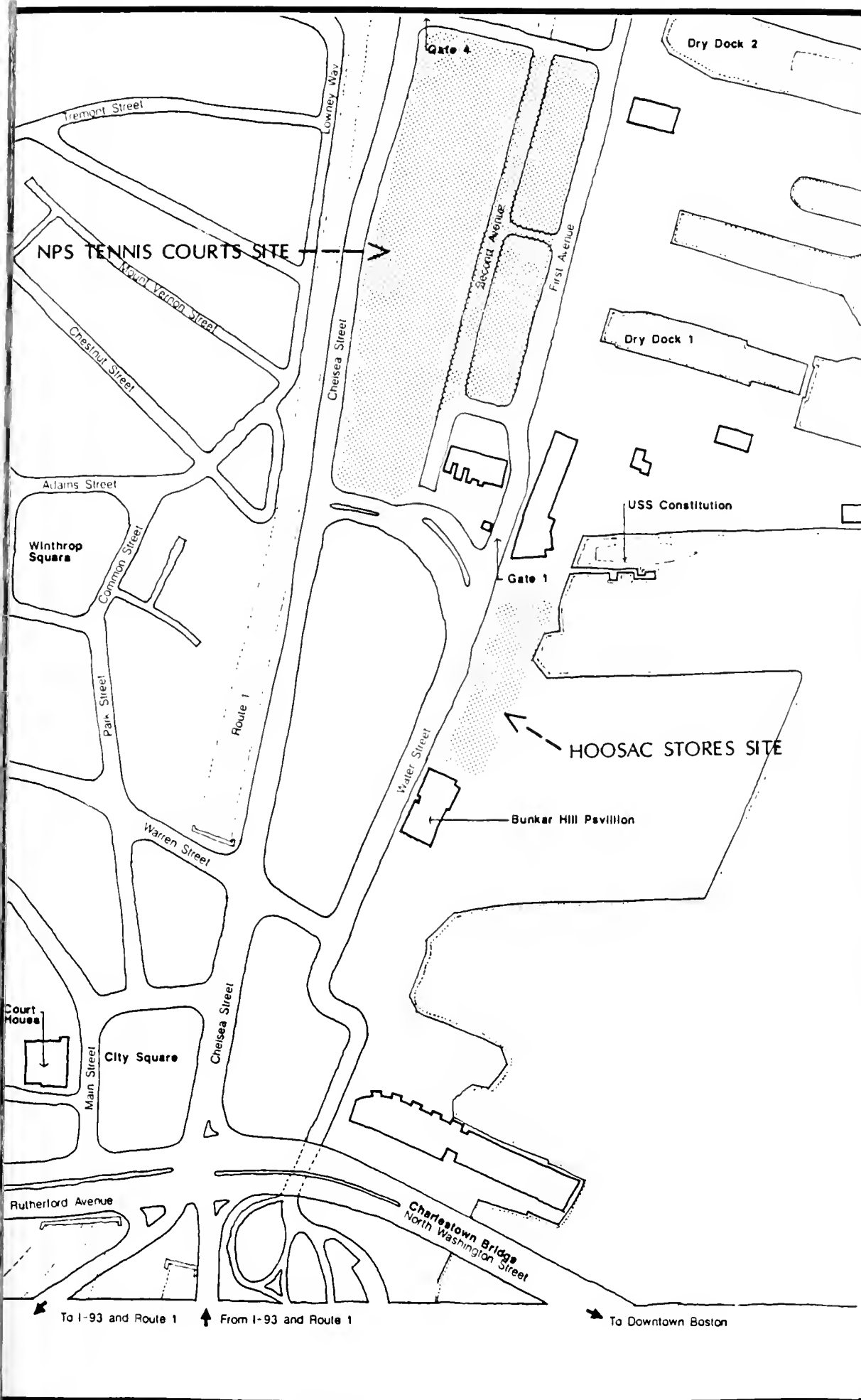


Figure 2
NEW ENGLAND
AQUARIUM

Potential
Aquarium
Parking Sites

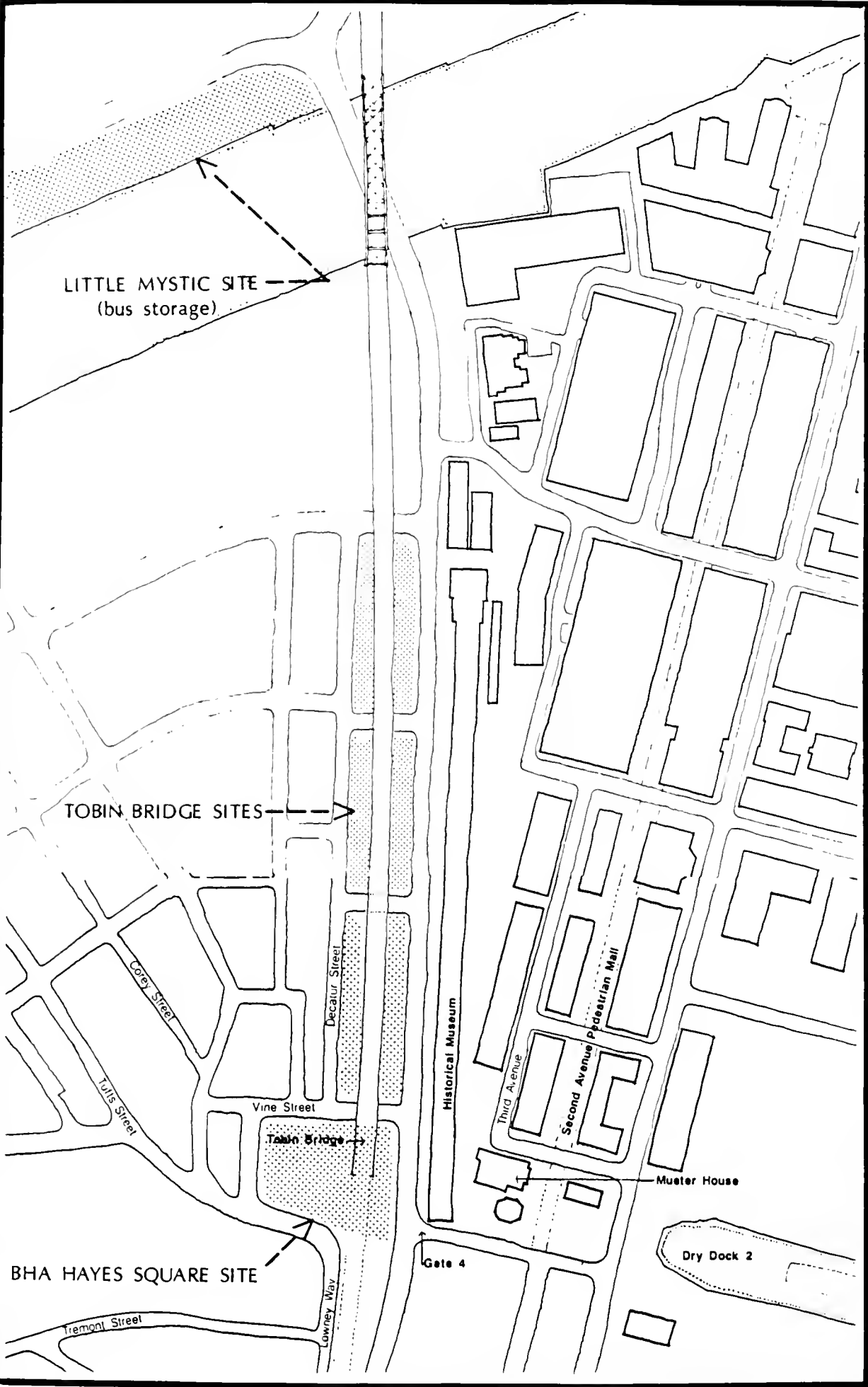


Figure 3
NEW ENGLAND
AQUARIUM

Potential
Aquarium
Parking Sites

The selection of a preferred site or sites for Aquarium parking will depend in part on the traffic impacts of alternative parking access locations. These are discussed in the following section related to traffic circulation impacts.

Traffic Circulation and Access Analysis Findings

While a new Aquarium facility in the Charlestown Navy Yard will generate increases in traffic, the majority of trips to and from the site will occur on weekends and during weekdays in the middle of the day in the months of July and August. These are both time periods when other background traffic is relatively low. While these weekend and midday peaks were assessed, the overall analysis indicates that the weekday evening rush hour will be the most critical time. This occurs since background traffic is highest during the PM peak hour and the Aquarium traffic, although small by comparison, is added to key intersections in the area. Figure 4 illustrates the relative contribution of Aquarium traffic to the total approach volumes at two of the key intersections.

Figure 5 illustrates the general pattern of regional access to the site. As can be seen most of the traffic from the major approaches will have to pass through the City Square area, whether it is approaching from Washington Street, I-93 or the Tobin Bridge. Figure 6 shows the location of the most critical intersections from a traffic operations standpoint.

The Intersection at City Square created by the Central Artery North Area (CANA) Project, with the changes as proposed by the Boston Transportation Department, will continue to function at an acceptable level of service, 'D', during the 1994 PM peak hour. While some additional traffic delay will occur as a result of the Aquarium traffic, City Square will remain at an overall satisfactory level of service. (Details on the impact of Aquarium traffic on individual turning movements and the concept of Intersection level of service are explained in greater detail in the body of the report.)

The other important Intersection from a traffic flow standpoint is at the Gate 4 Navy Yard entrance and Chelsea Street. Traffic flow impacts here will be a result of the location chosen for Aquarium parking; as follows:

- o Parking sites west of Gate 4 and accessed both from Chelsea and Water Streets (Hoosac Stores, the northwest NPS property, and the NPS Tennis Courts) will add very little traffic to this Intersection and will result in acceptable levels of service.
- o If parking sites east of the Gate 4/Chelsea Street Intersection are chosen (Hayes Square or the property beneath the Tobin Bridge), or if access to the NPS Tennis Court or northwest corner property is provided through the Navy Yard, traffic improvements will be required in the area of the Gate 4/Chelsea Street Intersection. Traffic access to these parking sites will operate at a satisfactory level of service if the following improvements are made:
 - To serve Aquarium parking within the Navy Yard, an additional lane must be added at the Gate 4 exit (Fifth Street) between Chelsea Street and First Avenue. This will provide two exit

lanes for traffic from Gate 4 to Chelsea Street during the PM peak. Based on a concept level assessment this widening appears to be feasible from an engineering standpoint.

- To provide access to parking sites north of Chelsea Street (either under the Tobin Bridge or at Hayes Square), Chelsea Street must be widened on the north side to provide an additional lane for right turns on the westbound approach and on the south side to provide an additional lane for left turns on the eastbound approach. Since the turning lanes require widening on the approach but not the departure sides of the intersection, the resulting five-lane section would be offset at the garage entrance. The widening of Fifth Street at Gate 4 as previously described is also necessary. Based on a concept level assessment both of these improvements appear to be feasible from an engineering standpoint.

Transit and Pedestrian Access Analysis Findings

The goal of having 25% of Aquarium visitors reach the Charlestown site via means other than automobile is achievable with improvements in pedestrian facilities from downtown, an attractive water shuttle link to the central waterfront and improved bus connections to nearby MBTA rapid transit lines. The use of water shuttle service fits well with the theme of the Aquarium and would not be subject to the variation of downtown Boston traffic. The analysis shows that two boats, with capacity of 150 passengers, would be required during peak summer periods to reach the 25% goal. Service would be provided every 15 minutes. It is also important to note that the walking environment between downtown and the Navy Yard will be greatly improved as a result of both the CANA project and the depression of the Central Artery. Although it is a relatively long distance, a good signing system could encourage more visitors to walk from North Station or the Haymarket/Faneuil Hall area. Additional efforts to encourage public transportation should involve shuttles between nearby MBTA stations (North Station, Community College and Kendall) and the Navy Yard.

Special Events

On days when major events occur in Charlestown, such as Bunker Hill Day or the arrival of tall ships, special transportation management measures will be required to handle large crowds. The impact of Aquarium traffic during these periods and possible transportation management actions that can be taken by the Aquarium to mitigate these impacts will be addressed as additional, more detailed environmental studies are completed.

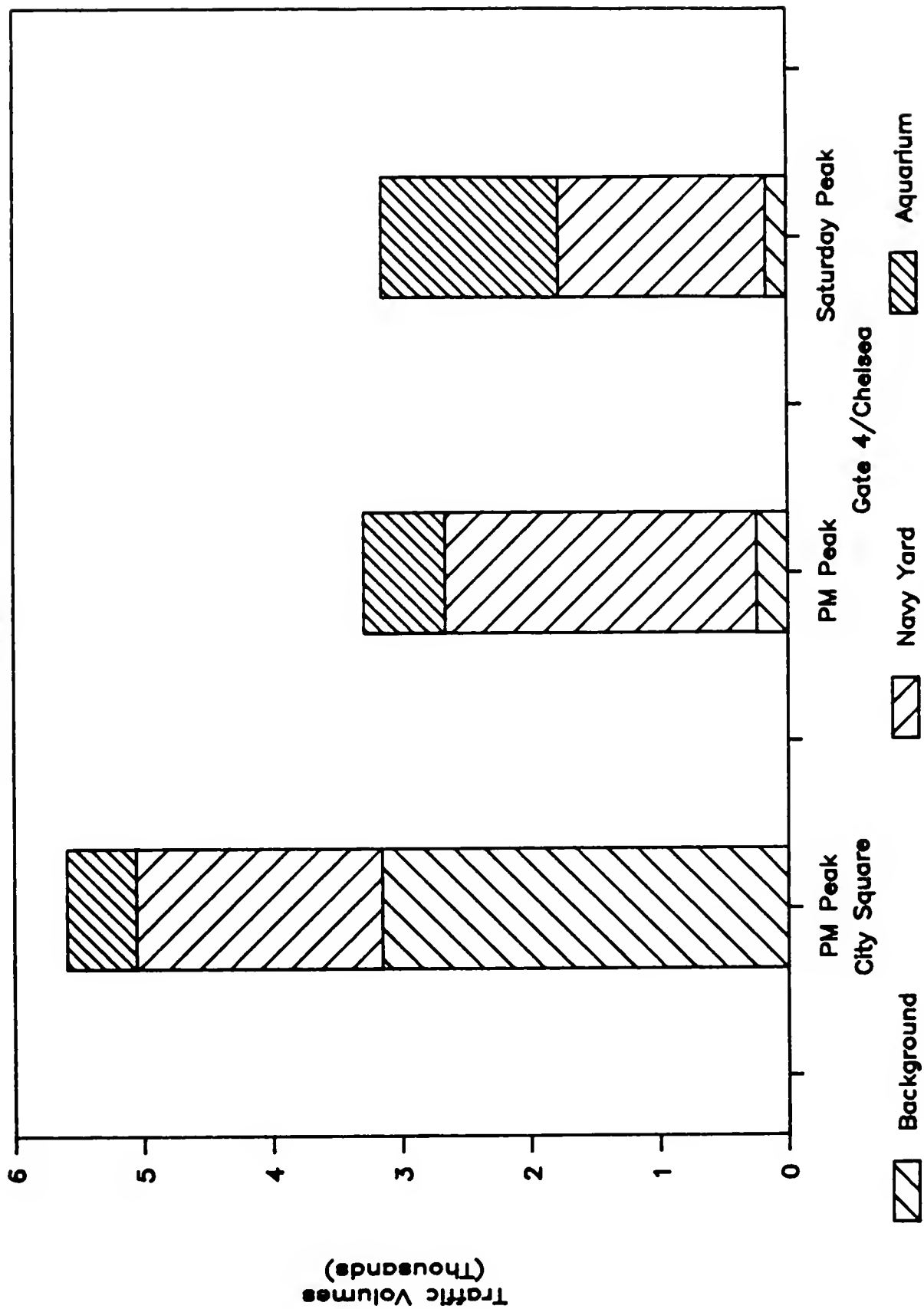
The remainder of this report provides documentation of the findings described above, along with more detailed descriptions of the transportation services required for the proposed new Aquarium site. The remaining sections include:

- o Background data,
- o Transportation access assumptions,
- o Traffic analysis results,
- o Parking analysis results, and
- o Transit analysis results.

Figure 4

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1994 Intersection Volumes



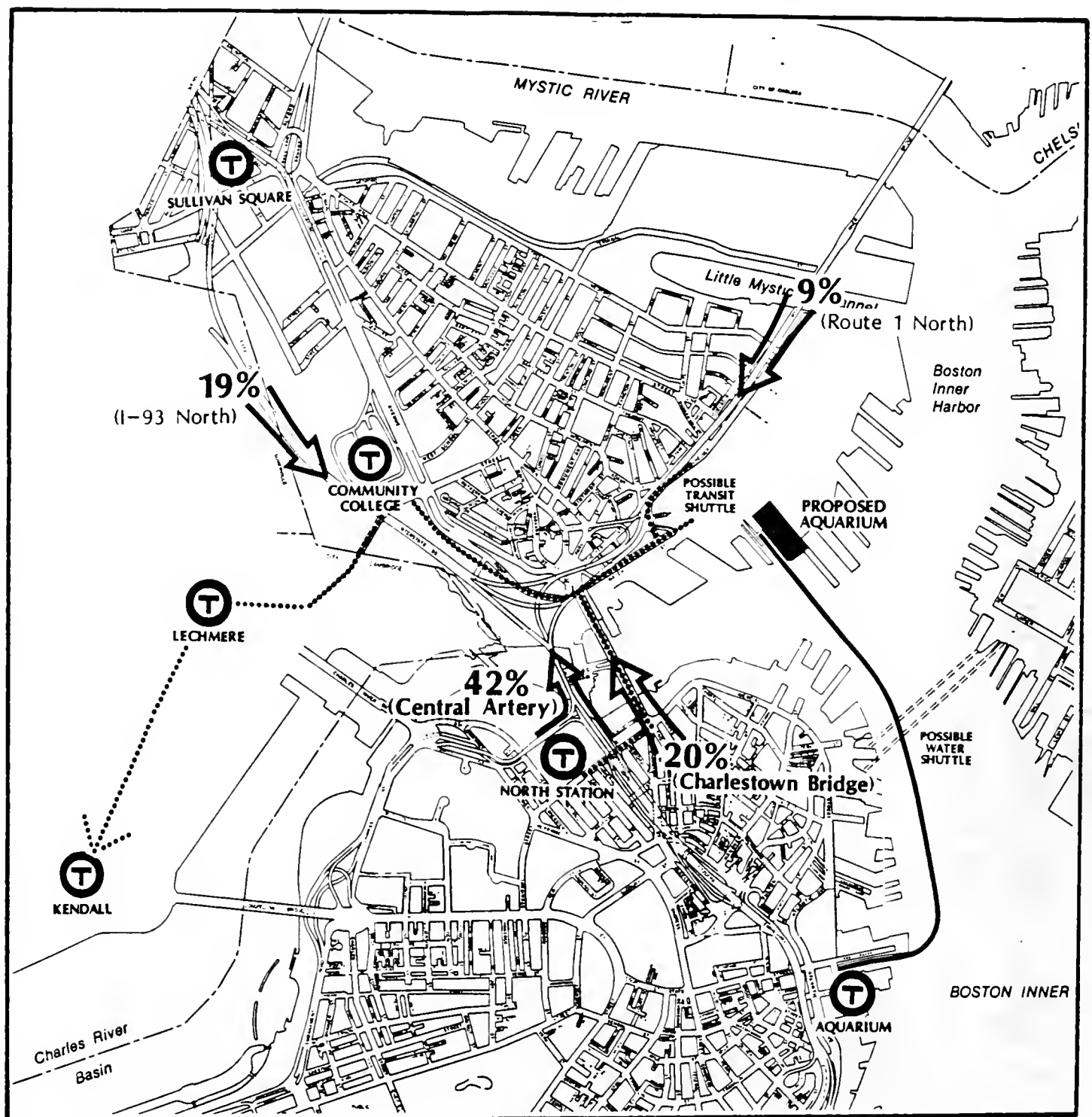


Figure 5

NEW ENGLAND AQUARIUM

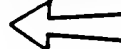
Access to Aquarium Site

..... Possible Transit Shuttle

— Possible Water Shuttle



Existing MBTA Stations



% of Aquarium Traffic by Major Corridor

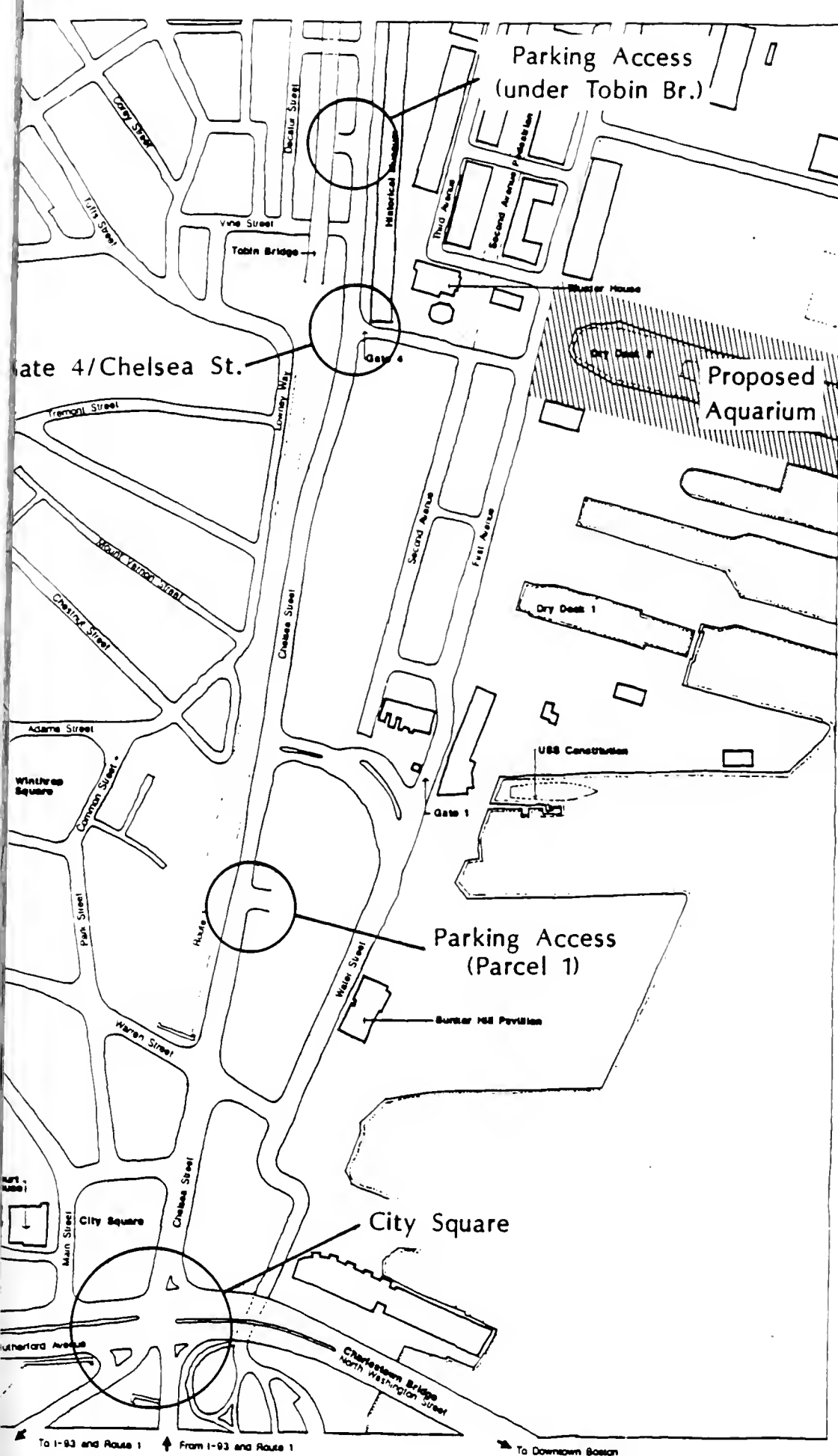


Figure 6

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Analysed
Intersections



AQUARIUM

II. BACKGROUND DATA

This section describes how visitor forecasts for Aquarium attendance and employee travel demand, along with forecasts of other activity in the Navy Yard, were developed for the 1994 design year. The latter forms the background traffic conditions to which travel associated with the new Aquarium facility activity is then added. A design year of 1994 was chosen since by this year the balance of development in the Navy Yard should be complete, the new Aquarium facility would be fully operational, and construction of the CANA Project and In City Square should be completed.

1. Aquarium Travel Forecasts

Travel demand associated with the Aquarium facility will be a function of both Aquarium employees and visitors to the new facility.

Estimates of Aquarium employment levels were provided by the New England Aquarium. In the 1994 design year, it is estimated that 300 employees would work at the facility on a typical peak summer day, and that half of these employees would travel to and from work during the morning and evening peak hours.

1987 visitation information for the New England Aquarium was obtained directly from the Aquarium staff. Tables 1 and 2 show the 1987 total visitation volume of 1,261,180 broken down by month, day and hour. As shown in Table 1, the monthly volumes vary considerably throughout the year. Peak visitation occurs in August, and is more than three times greater than the lowest month, which is January. Daily and hourly levels of visitation for August are shown in Table 2. The largest daily volume occurs on Saturday. Hourly peaks for each day occur at various times between 12:30 PM and 4:30 PM.

A number of assumptions related to Aquarium visitation were tested. Based upon information provided by Aquarium staff, the existing average visit length is two hours. For the new Aquarium, this was raised to 2.5 hours to estimate the visitor departure volumes. An average vehicle occupancy (AVO) of 2.5 persons per vehicle was used. Following an initial round of analysis, a "working scenario" was selected for opening year 1994, as follows:

- o 2.1 million visitors/year;
- o 25% of visitors access by means other than private automobile;
- o Percentage of visitors in July and August is 32.4%;
- o Average vehicle occupancy of visitors arriving by car is 2.5; and
- o Average length of stay of two and one-half hours.

Table 3 shows the projected visitor volumes for 1994 compared with existing admissions. The future year scenario assumes that 25% of visitors arrive by means other than private auto and that 32.4% of total visitation occurs during July and August. Table 4 shows the daily and hourly distribution of visitors for August, 1994 under the working scenario. It is anticipated that the peak day will continue to be Saturday, and the hourly peaks will occur at various times during the early afternoon. To conduct the transportation analysis, two peak conditions were chosen

TABLE 1
MONTHLY AQUARIUM ADMISSIONS

	1987 ADMISSIONS	PERCENT OF TOTAL
JANUARY	52,154	4.1%
FEBRUARY	90,787	7.2%
MARCH	100,745	8.0%
APRIL	113,936	9.0%
MAY	117,187	9.3%
JUNE	119,498	9.5%
JULY	161,354	12.8%
AUGUST	176,284	14.0%
SEPTEMBER	94,146	7.5%
OCTOBER	93,569	7.4%
NOVEMBER	85,755	6.8%
DECEMBER	55,765	4.4%
	-----	-----
	1,261,180	100.0%

TABLE 2
NEW ENGLAND AQUARIUM
1987 DAILY ARRIVALS
(persons)

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
9:30-10:30 AM	234	169	195	104	113	179	145
10:30-11:30	644	623	566	538	521	713	457
11:30-12:30 PM	678	712	819	802	887	1023	634
12:30- 1:30	678	582	680	282	870	1156	874
1:30- 2:30	696	672	750	276	859	1179	980
2:30- 3:30	674	701	644	294	857	1040	1046
3:30- 4:30	438	453	418	214	550	1133	903
4:30- 5:30	270	213	259	89	350	713	584
5:30- 6:30	31	20	147	27	225	237	181
6:30- 7:30			113		183	16	14
7:30- 8:30			49		101		
8:30- 9:30 PM			10		27		
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DAILY TOTALS	4343	4145	4650	2626	5543	7389	5818

TABLE 3
MONTHLY AQUARIUM ADMISSIONS

	1987 ADMISSIONS	1994 ADMISSIONS (32.4% of visitors in July and August)
JANUARY	52,154	75,600
FEBRUARY	90,787	140,700
MARCH	100,745	157,500
APRIL	113,936	178,500
MAY	117,187	184,800
JUNE	119,498	186,900
JULY	161,354	321,300
AUGUST	176,284	350,700
SEPTEMBER	94,146	144,900
OCTOBER	93,569	144,900
NOVEMBER	85,755	132,300
DECEMBER	55,765	81,900
	<hr/> 1,261,180	<hr/> 2,100,000

TABLE 4

NEW ENGLAND AQUARIUM

1994 DAILY ATTENDANCE/AUGUST
(2.1 million yearly)

	MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY		SATURDAY		SUNDAY	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
9:30-10:30	464		335		386		206		224		355		287	
10:30-11:30	1276		1234		1122		1066		1032		1413		906	
11:30-12:30	1343	232	1411	167	1623	193	1589	103	1758	112	2027	177	1256	144
12:30-1:30	1343	870	1153	785	1347	754	559	636	1724	628	2291	884	1732	596
1:30-2:30	1379	1310	1332	1323	1486	1372	547	1328	1702	1395	2336	1720	1942	1081
2:30-3:30	1336	1343	1389	1282	1276	1485	583	1074	1698	1741	2061	2159	2073	1494
3:30-4:30	868	1361	898	1242	828	1417	424	553	1090	1713	2245	2313	1789	1837
4:30-5:30	535	1357	422	1360	513	1381	176	565	694	1700	1413	2198	1157	2007
5:30-6:30	61	2132	40	2054	291	1052	53	945	446	1394	470	2153	359	1931
6:30-7:30					97	671			200	892	32	3037	28	2438
7:30-8:30					20	665			53	1046				
DAILY TOTALS	8606	8606	8213	8213	8990	8990	5203	5203	10621	10621	14641	14641	11528	11528

for analysis. Since peak Aquarium activity will occur on a Saturday afternoon in August, this was chosen as one critical period. A weekday afternoon in August was chosen as the other critical time for analysis, because this is when the balance of activity in the Navy Yard will create peak traffic flows and the surrounding highway network will also be at peak condition. A typical Wednesday in August was chosen to represent the critical weekday condition.

2. Background Travel Forecasts

The key element in forecasting background travel relates to the level of travel generated by other development in the Charlestown Navy Yard. At the present time the Navy Yard contains approximately 800,000 square feet of office space and just under 700 residential units. Most of the remaining available development parcels are located at the eastern end of the Yard, in the area known as "Yard's End". Traffic impacts have played an important role in assessing the level of development that can be accommodated on these remaining parcels. The Boston Redevelopment Authority has recently proposed a less intensive build-out than previously suggested, which was detailed in a report distributed on May 10, 1988. This latest level of development is summarized in Table 5.

TABLE 5
PROPOSED CHARLESTOWN NAVY YARD
BUILD-OUT DEVELOPMENT

Traditional Office	825,000 Square Feet
Office/Medical Research	825,000 Square Feet
Local Retail	40,000 Square Feet
Exhibit/Museum	214,000 Square Feet
Hotel	250 Rooms
Residential	1,829 Units
Clinic/Medical Facility	50,000 Square Feet

A recent analysis conducted for the Boston Redevelopment Authority indicated that between 3,600 and 4,300 parking spaces would be needed in the Navy Yard, with the range depending on the extent to which joint use of spaces between residents and employees can be implemented.¹ This same analysis indicates that the exit from Gate 5 to Chelsea Street must be widened to two outbound lanes to accommodate traffic levels associated with the expanded parking supply.

In addition to development in the Navy Yard itself, the Tudor Wharf site adjacent to the Charlestown Bridge was assumed to be redeveloped as per the plans included in the recently filed Draft Environmental Report.² For purposes of the analysis the larger Option #2, including the MassPort parcel was used.

¹ "Transportation Analysis for Charlestown Navy Yard", TAMS Consultants, Inc., July 28, 1988.

² "Tudor Wharf Draft Environmental Impact Report", EOEA #6744, September 1988, Fort Point Associates.

Other background traffic in the Charlestown area was assumed to grow in line with forecasts developed by the Central Transportation Planning Staff (CTPS) as part of the CANA Project analysis. Included in this background traffic are other significant traffic generators, such as the USS Constitution. Currently, 25% of the people who visit the USS Constitution also visit the Aquarium on the same day. The same overlap is assumed for 1994, when the USS Constitution and the Aquarium will both be located in the Navy Yard. At this stage of analysis this approach is in line with the other conservative assumptions being made.

In analyzing the traffic impacts of the proposed Navy Yard development two key intersections were found to be the controlling points, as follows (see Figure 6):

- o The Intersection of Chelsea Street with the Gate 4 entrance; and
- o The City Square Intersection of Rutherford Avenue, Chelsea Street and the I-93 ramps (currently under construction as part of the Central Artery North Area Project).

Background volumes for the Chelsea Street/Gate 4 Intersection were assumed the same as those forecast for the 1994, Navy Yard build-out condition with the addition of the Tudor Wharf development. The City Square Intersection will be totally rebuilt as part of the Central Artery North Area (CANA) Project. This rebuilt Intersection, including modifications proposed by the Boston Transportation Department (BTD), was used as the basis for the analysis.³

Figure 5 shows the regional origins of Aquarium traffic, as well as MBTA stops which might serve as potential shuttle locations. The figure shows that most Aquarium traffic will originate from the south and will come through Boston. Virtually all regional traffic, however, must travel through City Square under the CANA project design.

³ In analyzing City Square, background traffic levels for those vehicles not travelling to or from Chelsea Street were the same as those used by the Department of Public Works in their planning work for the CANA project. The work completed for the CANA project also included the assumption that approximately 70% of the PM peak hour traffic travelling to and from the Navy Yard would go through City Square.

III. TRANSPORTATION ACCESS ASSUMPTIONS

The traffic impacts of the proposed Aquarium will vary depending on the location of parking facilities, the level of public transportation usage among visitors and the direction of access/egress of those who reach the site by automobile. Five potential parking locations were examined (see Figures 2 and 3):

- o West of the Gate 1 Navy Yard entrance at the current site of the Hoosac Stores building,
- o Within the Navy Yard, adjacent to the proposed Aquarium under the Tennis Courts on the National Park Service(NPS) site, and possibly expanded to include the northwest corner of the NPS property,
- o East of the Gate 4/Chelsea Street Intersection under the Tobin Bridge,
- o The Boston Housing Authority/Hayes Square site partially under the Tobin Bridge across from Gate 4; and
- o Along the Little Mystic Channel near the Container Terminal (bus storage only).

All five alternatives will bring Aquarium traffic through the first key analysis intersection, City Square. The first site, Hoosac Stores, will not increase the level of traffic going through the Gate 4/Chelsea Street Intersection. The analysis indicates that a new intersection created to serve the Hoosac Stores site would function at a satisfactory level of service under all alternatives.

The other sites require that traffic bound for the Aquarium pass through the Gate 4/Chelsea Street Intersection. The site inside the Navy Yard on the NPS property would require that traffic enter and exit through Gate 4, unless an access point through Gate 2 from Water Street were developed. Analysis of new intersection on Water Street at Gate 2 indicates that a garage access at this location would work at a satisfactory level of service.

The two sites under the Tobin Bridge would require either the creation of a new 'T' Intersection east of Gate 4 or the development of a garage entrance across from Gate 4, creating a four-way intersection.

Traffic analysis shows that under the working scenario, the Gate 4/Chelsea Street Intersection, with improvements, can accommodate the additional traffic generated by the Aquarium. These improvements include:

- An additional lane must be added to Fifth Street between Chelsea Street and First Avenue in order to service Aquarium parking within the Navy Yard. This will enable two exit lanes to be provided for traffic from Gate 4 to Chelsea Street during the PM peak.
- In order to provide parking north of Chelsea Street (either under the Tobin Bridge or at Hayes Square) an additional lane must be added to Chelsea Street on the westbound approach and on the eastbound approach, creating a five-lane section. The widening of Fifth Avenue described above is also necessary.

A preliminary, concept level assessment of these improvements indicates that they are physically feasible to construct.

Under current design, the additional traffic from the Aquarium would cause Gate 4 to fall (level of service 'F'). The Gate 4/Chelsea Street Intersection is severely constrained by a number of factors. At Navy Yard build-out the majority of peak-hour traffic will enter and leave the Yard via Gate 5. The Yard's End parcels, where most new development will take place, are located near Gate 5 and the majority of Yard parking will be located there as well. Most of the traffic entering and leaving Gate 5 (estimated to be approximately 80 percent) will travel through City Square. It is the City's policy to discourage other alternative routes, all of which would use the neighborhood streets of Charlestown. Therefore, virtually all traffic entering and leaving the Navy Yard will pass through the Gate 4/Chelsea Street Intersection. Fifth Avenue, which intersects Chelsea Street at Gate 4, is a narrow two-lane street. Under Navy Yard build-out conditions, the Gate 4/Chelsea Street Intersection does function at an acceptable level of service ('D'), although there will be delays for vehicles exiting from Gate 4. The traffic imposed by additional Aquarium parking in the Navy Yard or east of Gate 4 will be enough to cause this intersection to operate below an acceptable level of service both during the weekday PM peak hour and Saturday peak hour. It is also important to note that additional parking in the Navy Yard could be served without these improvements, if Gate 1 or Gate 2 is opened.

Another key assumption in the analysis involves the level of public transportation usage by Aquarium visitors. The most recent survey taken by the Aquarium at the existing downtown site showed that 42% of visitors use public transportation, 41% drive and the remainder either walk or use other modes (taxis, shuttle buses). The downtown site is served directly by the MBTA Blue Line and is within easy walking distance of other downtown tourist attractions. While existing public transportation to the Navy Yard is limited, bus and water shuttle service will be improved as development continues. Most new transit service will be primarily oriented toward Yard employees, but with good marketing significant numbers of Aquarium visitors could be attracted as well. Possible surface transportation options include bus shuttles from North Station, Community College, Kendall and/or Charles stations. An existing railroad right-of-way may be available between Community College station and the Navy Yard. Bus or jitney service provided along this exclusive right-of-way could serve both MBTA passengers and weekend overflow parking at a new garage planned for the Community College area.

Previous analysis has indicated the need for direct public transportation service through the Navy Yard. This service would be enhanced by the opening of Gate 1 to transit vehicles, permitting the circulation of buses through Gate 1, along the length of First Avenue and out Gate 5. While water transportation will probably be the primary public transportation mode for Aquarium visitors, improved surface connections will also be important in reaching the 25% non-private auto goal.

A water transportation service will be oriented toward the large number of tourists who are already visiting downtown Boston and will visit the Aquarium as part of their overall experience in the City. A strong marketing and signing program will be needed to guide visitors to the downtown boat dock, and the water shuttle itself will hopefully provide information on the Aquarium, the USS Constitution and other attractions in the area. The Navy Yard landing for the

shuttle should connect directly to the Aquarium at Drydock #2. Because 25% visitor access by means other than private auto appears to be achievable and is the stated goal of the Aquarium, this number was incorporated into the analysis. It should be noted that the 25% includes walking, and that the walking environment between downtown and the Navy Yard will be greatly improved when the CANA Project and the Central Artery Depression are completed.

The level of traffic during the weekday PM peak period will also be impacted by the number of Navy Yard employees using public transportation. Transit usage among the three major tenants in the Yard (Massachusetts Water Resources Authority, Boston Redevelopment Authority and Massachusetts General Hospital) currently exceeds 50% as a result of strong ridesharing and shuttle bus programs. Because the BRA is committed as a matter of policy to achieve at least a 45% transit mode split for Navy Yard employees, this level of transit use by Navy Yard and Aquarium employees was assumed in the analysis. The results of the traffic analysis and the implications for parking and transit requirements are described in the following sections.

IV. TRAFFIC ANALYSIS FINDINGS

Traffic analysis is conducted using the concept of level of service. Level of service at signalized intersections is measured in seconds of delay and defined as "average stopped delay per vehicle". This delay is a measure of driver discomfort and lost time. Level of service 'B', for example, means that a driver waiting at an intersection will experience an average delay of between five and fifteen seconds before going through the intersection. Level of service 'A' describes traffic flow with the shortest delays, ranging to level of service 'F' with the longest delays. The specific delays associated with each level of service are shown in Table 6.

In urban neighborhoods such as the Navy Yard area level of service 'D' is considered acceptable. Providing the required physical capacity to achieve level of service 'A' or 'B' is generally not economically or physically feasible in this type of area. It should also be noted that the level of service represents the average of all movements made in the intersection. When the overall level of service is 'D', it is possible that some specific turns may experience level of service 'E' or 'F' while others would be 'A', 'B' or 'C'.

TABLE 6
LEVEL OF SERVICE CRITERIA FOR
SIGNALIZED INTERSECTIONS

Level of Service	Stopped Delay Per Vehicle (Seconds)
A	≤ 5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	> 60.0

Tables 7 and 8 summarize the level of service for a summer peak season weekday PM peak hour and Saturday peak hour for an assumed annual visitation level of 2.1 million. For all levels it is assumed that July/August visitation increases to 32.4% of the annual total, that 25% of Aquarium visitors travel by means other than the automobile and that 45% of Navy Yard and Aquarium employees use public transportation. It is also assumed that parking would be either in the Navy Yard or east of the Gate 4/Chelsea Street Intersection and that Gate 1 would not be available for vehicular access to the Navy Yard. Level of service data are provided for City Square, the Gate 4/Chelsea Street Intersection and for a Gate 4/Chelsea Street/parking garage entrance Intersection. The latter Intersection would exist only if parking is provided under Tobin Bridge or at the BHA Hayes Square site. This would result in a new four way Intersection at Gate 4 and Chelsea Street. The left column in the table indicates the level of service under the current geometry of the Chelsea Street/Gate 4 Intersection. The right column shows the level of service for a Gate 4/Chelsea Street Intersection which would be improved as described in the previous section. The tables show that with the

Improvement, Aquarium parking and traffic can be accommodated either in the Navy Yard, under the Tobin Bridge or at Hayes Square.

The other key intersection involved in the analysis is the City Square Intersection, which is being reconstructed as part of the CANA project. In evaluating City Square, a PM peak hour of 4:30 PM to 5:30 PM was used. Background volumes were factored to account for the fact that overall PM peak hour traffic is approximately 9% lower in August than in an average month. August, however, is the peak month for Aquarium visitation.

The City Square Intersection will connect Rutherford Avenue, the Charlestown Bridge to Boston, the ramps to and from I-93 and Chelsea Street. It is anticipated that most of the traffic travelling to and from the Navy Yard will pass through this intersection. Under other project designs the intersection was projected to operate at level of service 'F', according to an analysis conducted for the Boston Transportation Department (BTD)⁴. As a result, the BTD has proposed a redesign which would operate at level of service 'D', although three individual moves would operate at 'E' or 'F'. This design, which involves minor widenings, addition of turning lanes and removal of some parking on Chelsea Street, has not yet been accepted by the Massachusetts Department of Public Works.

The amount of peak traffic added to City Square from the Aquarium would be roughly the same, regardless of parking facility location. At 2.1 million visitors per year the overall level of service at City Square will remain at level of service 'D' although three additional moves will decline from level of service 'D' to level of service 'E'. This makes a total of five moves at level of service 'E'. It is important to note, however, that this analysis is based on conservative assumptions, including one related to the analysis technique itself. The level of service analysis assumes a "saturation flow rate" of 1800 vehicles per hour per lane. This is a nationally recognized standard, but there is evidence that the actual rate in the Boston area is higher at some locations. This means that more vehicles may actually get through an intersection than is being assumed in the analysis. If a higher saturation flow rate is used, the delays shown for City Square in Table 7 would be lower.

Table 8 summarizes the level of service for a summer Saturday peak hour. Aquarium traffic is highest on Saturday, although background traffic is considerably lower than during the weekday peak hour. A set of traffic counts was taken on a Saturday in July of 1988 to provide a basis for estimation of Saturday background traffic. This base was then factored up to account for the proposed build-out of the Navy Yard and Tudor Wharf. The analysis shows that the location of a garage in the Navy Yard or under the Tobin Bridge would result in unacceptable congestion at Gate 4/Chelsea Street on Saturdays. If the Fifth Street approach and the intersection itself are improved, however, a satisfactory level of service will be achieved.

⁴Vanasse Hangen Brustlin, Central Artery North Area Local Intersection Analysis, prepared for Boston Transportation Department, November, 1987.

Table 7

DELAY AND LEVEL OF SERVICE
 45% Background Transit/25% Aquarium Transit
 32.4% of Visitors In July and August
 Weekday PM Peak Hour

	Existing Gate 4 Geometry		Improved Gate 4 Geometry	
	Delay	LOS	Delay	LOS
EXISTING TRAFFIC VOLUMES				
City Square	32.2	D*	32.2	D*
Gate 4/Chelsea St.	12.7	B	N/A	
1994 WITH AQUARIUM (2.1 Million Visitors)				
City Square	37.0	D*	37.0	D*
Gate 4/Chelsea St. (1)	~	F	8.9	B
Gate 4/Garage/Chelsea St. (2)	~	F	12.7	B (3)

* Intersection overall operates at level of service D or better, but at least one approach operates at level of service E or F.

~ Demand is so much greater than capacity that meaningful results cannot be attained.

(1) Aquarium parking in Navy Yard.

(2) Aquarium parking east of Gate 4/Chelsea St. Intersection.

(3) Chelsea St. widened to 5 lane section.

Table 8

DELAY AND LEVEL OF SERVICE
45% Background Transit/25% Aquarium Transit
32.4% of Visitors In July and August
Saturday Peak Hour

	Existing Gate 4 Geometry		Improved Gate 4 Geometry	
	Delay	LOS	Delay	LOS
EXISTING TRAFFIC VOLUMES				
Gate 4/Chelsea St.	8.9	B	N/A	
1994 WITH AQUARIUM (2.1 Million Visitors)				
Gate 4/Chelsea St. (1)	73.7	F	7.5	B
Gate 4/Garage/Chelsea St. (2)	66.7	F	11.0	B (3)

* Intersection overall operates at level of service D or better,
but at least one approach operates at level of service E or F.

(1) Aquarium parking In Navy Yard.

(2) Aquarium parking east of Gate 4/Chelsea St. Intersection.

(3) Chelsea St. widened to 5 lane section.

V. PARKING ANALYSIS FINDINGS

Parking demand associated with Aquarium visitors and employees was estimated for both average and peak summer weekday conditions and average and peak summer Saturday afternoon conditions in the month of August. In both cases, a sensitivity analysis of transit mode splits ranging from 15% to 25% was tested, and it was assumed that 32.4% of visitation would occur in July and August. Estimated levels of parking demand are shown in Table 9. Under a scenario of 2.1 million visitors, approximately 700 spaces would be required during a typical weekday throughout the year and nearly 1200 weekday spaces would be required in August at a 25% transit mode split. Although Aquarium parking demand will be highest on Saturdays, the weekday demand will determine the size of any needed parking facility. Because significant amounts of the parking in the Navy Yard will be dedicated to employees, there will be excess space in the Yard to absorb the additional Aquarium related parking demand on Saturday. The most likely location for providing overflow parking within the Yard is the existing Garage near Gate 5. Locations outside the Navy Yard, including proposed new garages at North Station and Community College, will also be evaluated.

TABLE 9

1994 AQUARIUM PEAK VISITOR AND EMPLOYEE PARKING DEMAND
2.1 MILLION VISITORS/25% TRANSIT
(32.4% OF VISITORS IN JULY AND AUGUST)

	Weekday	Saturday
September-June	683	1029
July-August	1171	1819

The overall parking supply in the Yard will be in the range of 3600-4300 spaces depending on the amount of employee transit use and the amount of joint use between office and residential uses. (Joint use means that a parking space can be used by both a daytime employee and a resident who drives his or her car to work during the day and returns in the evening.) While up to 40% of the spaces could be jointly used, there will still be adequate overflow parking for the Aquarium on Saturday.

During the week no excess parking will be available in the Navy Yard, and the development of an Aquarium facility will require the provision of an average 700 spaces with up to 1200 parking spaces needed during the peak months of July and August. The decision on parking facility sizing is an important one for the Aquarium. The construction of a smaller facility will require the Aquarium to develop an extensive transit system if projected visitation levels are to be accommodated. If a larger parking facility is constructed, it will, by its very existence, make higher levels of transit ridership harder to achieve. Therefore, the Aquarium must decide on a marketing strategy before proceeding with a parking facility.

It is important to note that the peak parking demand will occur only during July and August. At other times, a smaller facility will be adequate. Therefore, the use of smaller facilities may be appropriate, one of which would be located further from the Aquarium and service overflow during the peak months only. A final consideration is whether a garage might be designed to accommodate other needs, such as parking for National Park visitors, new development in City Square, or Charlestown residents.

The Boston Redevelopment Authority is currently examining the feasibility of four sites for Aquarium parking. Although this analysis is not yet complete, estimates of capacities have been developed:

- o National Park Service Tennis Courts (subsurface) - 500 spaces (could be expanded with waterproofing)
- o Hoosac Stores - 108 spaces (not currently under consideration due to small capacity and high cost)
- o BHA Hayes Square - 500 to 600 spaces
- o Under Tobin Bridge - 300 (surface only)/ 900 (three-level structure)

A variety of options are available for meeting Aquarium parking demand, including some combination of the above sites and remote parking. Another potential parking site is CANA Parcel 1, located just outside the Gate 1 entrance. Parcel 1, bounded by Water and Chelsea Streets will be created at the completion of the CANA project, and does have the capacity to meet much of the Aquarium parking demand. The disposition of this parcel, however, is currently unresolved and will be decided by the Massachusetts Department of Public Works.

VI. TRANSIT ANALYSIS

Potential levels of transit use by visitors to the Aquarium could be as high as 1140 trips per hour during peak summer Saturday afternoon conditions with total daily Saturday ridership reaching 7320 in peak conditions. Table 10 shows the number of total daily and peak hour transit users travelling to and from the Aquarium on both weekdays and Saturdays. The table shows the number of riders to and from the Aquarium during the hour of highest ridership. Table 11 shows the hourly breakdown of transit ridership for peak weekdays and peak Saturdays.

TABLE 10
1994 TRANSIT RIDERSHIP
BY NAVY YARD AQUARIUM VISITORS
(25% TRANSIT)

	Weekday	Saturday
Daily Total	4492	7320
Peak Hour Total	715	1139
PM Peak Hour Total	473	N/A

Transit access to the site can be accomplished in a number of ways. Possible scenarios include:

- o Operation of a water shuttle between Central Wharf on the Downtown waterfront and Drydock #2 in the Navy Yard. Under this scenario, Aquarium visitors would be encouraged to reach the Charlestown facility by first travelling to downtown and then boarding a water shuttle. A marketing concept which ties the boat ride to the Aquarium and other Charlestown attractions such as the USS Constitution and Bunker Hill would be very important in attracting tourists to the service.
- o Operation of a shuttle bus or van system between the downtown waterfront and Drydock #2 in the Navy Yard. This would serve the same function as the water shuttle in the above scenario.
- o Operation of shuttle bus or van system to connect the Navy Yard to nearby MBTA rapid transit and commuter rail stations. The most logical points to connect would be Sullivan Square and/or Community College (Orange Line North), North Station (Green Line, Orange Line South, and Commuter Rail), and either Charles or Kendall on the Red Line.

Given the origins of visitors to the Aquarium, 25% visitor arrival by means other than automobile is likely to be achieved only if both water and land based

transit services are provided. A water shuttle designed to meet peak demand will be far more attractive to visitors than a bus service and could tap the large market of tourists who will combine a visit to the Aquarium and the USS Constitution with a visit to downtown sites such as Faneuil Hall Marketplace. In addition, a water shuttle can be operated reliably without worrying about the variability of downtown traffic.

The use of water shuttle service could reduce the need for surface transit service, although improved transit service is clearly needed to serve other future demands in the Navy Yard. The ridership data indicate that two boats are required during peak periods to serve demand. This would allow service to be provided with 15-minute headways, a level which would result in minimal waiting for passengers. While the water shuttle is somewhat more expensive than a ground transportation system, it would have a number of qualitative advantages in terms of comfort and relationship with the Aquarium experience and is probably essential to reach the goal of having 25% of Aquarium visitors reach the Navy Yard by means other than automobile.



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TABLE 11

1994 TRANSIT USE BY AQUARIUM VISITORS

WEEKDAY TRANSIT USE

TIME	Total Visitors		Visitors Using Transit (25%)	
	IN	OUT	IN	OUT
9:30-10:30	386		97	
10:30-11:30	1122		281	
11:30-12:30	1623	193	406	48
12:30-1:30	1347	754	337	189
1:30-2:30	1486	1373	372	343
2:30-3:30	1276	1485	319	371
3:30-4:30	828	1417	207	354
4:30-5:30	513	1381	128	345
5:30-6:30	291	1052	73	263
6:30-7:30	97	671	24	168
7:30-8:30	20	665	5	166

SATURDAY TRANSIT USE

TIME	Total Visitors		Visitors Using Transit (25%)	
	IN	OUT	IN	OUT
9:30-10:30	355		89	
10:30-11:30	1413		353	
11:30-12:30	2027	178	507	44
12:30-1:30	2291	884	573	221
1:30-2:30	2336	1720	584	430
2:30-3:30	2061	2159	515	540
3:30-4:30	2245	2314	561	578
4:30-5:30	1413	2199	353	550
5:30-6:30	470	2153	118	538
6:30-7:00	32	3038	8	759

